Title: E-learning in the computer science : some computer and methodology techniques

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E – learning in the Computer Science: Some Computer and Methodology Techniques

Abstract

E-learning is becoming a more and more common and popular form of learning in Poland and all over the world. Nowadays there are available different commercial as well as free platforms of distance learning for example: MOODLE, Claroline, Atutor, Dokeos and others. This fact, of course, has got a positive influence upon the availability and the relatively high speed of spreading of this form of learning. Unfortunately, the methodological aspects of distance learning of different subjects are not fully examined or analysed. In the following article one can find an attempt at answering some questions connected with the methods, technological and computer aspects of teaching computer science.

Key words: *computer science, model, e-learning, the matter, the spider scheme, MOODLE, UML (Unified Modeling Language)*

1. Methodological aspects of teaching computer science.

In a group of the basic subjects of the natural-mathematics science interest one can distinguish the computer science and maths.The course of the computer science should be considered as an element of an educative school system, in which the aims, context of teaching and the structure of the course are determined, first of all, by the general constracting and functioning rules of this system.

The most important features which describe the computer science as a subject are: systematic character, module structure, and spiral methods of learning. The practical experience of distance e-learning of the computer science and mathemat-

ics is not a common and existing experience examined enough and quite often it is generalized. So for that reason, there is a necessity of distance e-learning in the country and all over the world, the right analysis and examination of the above – mentioned problem are very important nowadays. The main problem and task are not only to equip schools with computers and software, but first of all, to save it methodologically, to prepare teachers for e-learning. For that reason one should consider all sets of problems, and particularly, in the sphere of the organization of the e-learning process in the computer science and other school subjects and the preparation of the required teaching and methodological safety.

Cognition in the process of learning (in every form) consists of three basic stages:

a) subjective associative presentation of the model of learning based on emotional and sensory experiance
b) modeling of the object of cognition
    1. formalization of the associative model (emptional)
    2. consideration of the 'scientific' model
    3. correction of the subjective model
    4. checking the precision of the formulated subjective model with the 'scientific' model
c) using the created model in solving tasks based on the prepared algorithms. (Polat, 2004)

These three stages are responsible for such fundamental issues as the following – model – algorithm; such levels of cognition as emotional, rational, and active ones; these cognitive needs such as – understanding – knowing – skills. The decisive moment becomes the description that such a 'scientific model' in some circumstances can and even should be presented to pupils as a rising dialectic model with its development.

The scientific view on the object of learning (model of 'learning') – always exists as a **model** (or lifetime models) formulated in the result of a long term searching. In it, in a 'rolled' form, are reflected only the essential compounds for solving a defined class of tasks, features, relationships. The scientific model is frequently reflected in the system of concepts, referred to the object of learning, and only in regularities (often expressed in patterns), reflecting the connections between the elements of the object.

One can notice that the patterns are often an indispensable and justified form, introducing the scientific model.

As far as the pattern is concerned, one can say that it is a cognitive model of an object, used in solving tasks, – explaining the pattern, based on the pattern itself,

not the way.Graphically expressed, the pattern is a trace in an informative area of cognitive object, left to the analysis process, emiting, and choosing the essential elements, mutual connections between them, – it is 'viewing' from a chosen point of view.' The formula does not have to be understood, it should be used. Together with this system of concepts, connected with the examined object (its thesaurus), it should be understood, it means understanding, how particular and essential indications make the context of every concept and what basic connections exist between the concepts. The system of concepts – a useless model of learning object, more precisely, a set of its models. Simultaneously, in the concepts (a term), just like in a formula, in a 'rolled' form, is reflected the historical process of the cognitive learning object.

It does not matter what group of authors has written the workbook, for example: chemistry, geography, astronomy, biology; there are the generally used forms presenting the system of knowledge of a particular area of a subject, such as: a periodical table of D. Mendelejew's elements, a geographical atlas with the collection of different maps, the heliocentric image of the world, the description and the structure of the Solar system with the planets arrangement, the development of the world, the creation of man in accordance with Darwin's theory and others. They represent the scientific model of a field object. And despite the teacher's subjective outlook, he is forced to work, first of all, and mainly, in the range of those models. In the computer science so far there have not been such single models of knowledge.

On the other hand, a teacher of biology, chemistry, astronomy, geography should not create from the beginning to the end in the field of chosen contexts and the presentation of school material

(while a teacher of computer science is forced to do it), his creative energy is directed, first of all, to his pedagogical craft and updating of his subject knowledge.A computer science teacher is forced to be an educator (to describe the course context) and a teacher trainer (to form methods and deductive materials) and as well as a pedagogue (looking for new forms of teaching). Despite the fact that there are more and more computer science workbooks by different authors and the choice is great, it is simultaneously a good tendency (there is a wide choice of school materials from the new subject) and a bad one (there can be chaos, misunderstanding, ignorance of the most essential categories of the computer science and in the end the teacher may choose not the best workbook from the scientific and methodological point of view, which may be very disadvantageous for a student).

Unfortunately, in the contemporary time, which is characterized by the mechanisms of the market economy, often not the best, but the most advertised workbook becomes the most popular. It is worth mentioning that there is a possibility for a teacher to prepare their own individual programme with their own methodological materials .But not all teachers are prepared to do it themselves and of course, they have not enough time. There are objective and subjective reasons for that. (Polat 2004, Smyrnova – Trybulska, 2007)

It is necessary to present teachers of the computer science with the scientific model of knowledge (a set of patterns, an 'atlas' to the workbook), which depends neither on types of techniques nor on the workbook author's point of view or profile of teaching. The right scientific model should be formulated on the standard basis and included into standards.

In the computer science the part of such an 'atlas' can fulfill logical patterns of concepts, because the ability to master the structure of concepts is one of the most important conditions of formalization, modeling, structuralization of data and messages, which lies at the root of everybody's intellectual ability. The application of logical patterns of concepts allows to describe a general attitude towards scientificaly justified methods of learning.

The application of logical patterns of concepts in e-learning has very special currency, because in the computer science, at present, a fixed set of concepts and system of generally considered attitudes, which from the scientific and pedagogical community's point of view, have not been formulated yet, should be necessarily reflected in the school course. It often leaves space for the significant but not always successful 'variation' in the learning context, particularly in these cases when a teacher and a student are geographically far away from each other. The application of logical patterns of concepts in large measure allows to avoid similar negative results. [Polat, Beszenkow, 2004, Michalin, 2003]

The description and idea of formulating logical patterns of concepts, and also their teaching advantages are possible to be presented in the following way. The concept of assimilation has its own form, context and structure. It means that free concepts are connected (generalized) with a set of values, features, characters in a described frame of reference .On the other hand, a concept (the key word) is a unit of material assimilation. Such units of data, which at their own level are a subject to the assimilation as total units, are called logically indivisible units of school material.

The most educative and obvious is the graphic presentation of a system of concepts and its structure Studies show that the simple description, the introduction

of concepts in a table or ‘ tree’ ‘ graph ‘ presentation, has a lower teaching value than the ‘spider net’ presentation.’

The “spider net” is such a scheme which exists as a central concept, context, range and sphere of usage which has to be explained. Around it there are placed concepts explaining the sense of the central concept from this or that point of view (the first level of key words). Each concept from the first level is explained by key words of the second level and so on. In Figure 1. a logical scheme is shown, illustrating the example structure of the ‘Algorithm’ concept.

It is rational, in many cases, to give up the commonly used demonstration of a hierarchical ‘tree’ structure of concepts, because it is connected with some sort of dependence relations. Because the concepts used by the description of cognitive object are often equally valued, reflecting different points of view on this object, different models. They may be connected with the ‘central’ concept not directly, but through certain other concepts .Because of this some new levels of concepts can appear (parallel to the central ones). One may say that a ‘spider net’ presentation gives a possibility to assimilate the concepts as synonymous, equally ‘important’ from the descriptive point of view of the examined object, letting us consider it from different sides. Apart from that, a spider net presentation allows (without losing systematic perception) to begin to consider any concept as a key word on the logical scheme from any free chosen place, at any freely chosen level, depending on the right perception of the material, individual style of cognitive acting, the aim of learning, etc.

In the same way as learning can start from a different level of each scheme, every key word is both a whole and a part, depending on the necessity of a cognitive unit. For that reason a teacher can base further teaching both on going out from the general rules to the detailed cases, and moreover, from the detailed cases to the general analysis of the object of learning, because in the process of familiarization and acting the scheme of logical concepts, the sphere of a close learner development is formulated in the direction desired by the teacher. Such schemes are easy and fast to make, using helpful instruments and functions, available in the system supporting the e-learning CLMS MOODLE. While working on such a course one can choose the automatic or the manual option of forming the hipertext cross-references needed for schools resources (lessons, files, notes in vocabulary, etc.), including the key words and concepts already existing in texts.

If necessary, at any moment a student can use the right cross-reference and learn more about the context of a specific concept. Besides that there is such a possibility in the course to make (by a teacher or a student) one’s own thematic vocabulary, divided into subcategories to which access is free at any moment of the learning

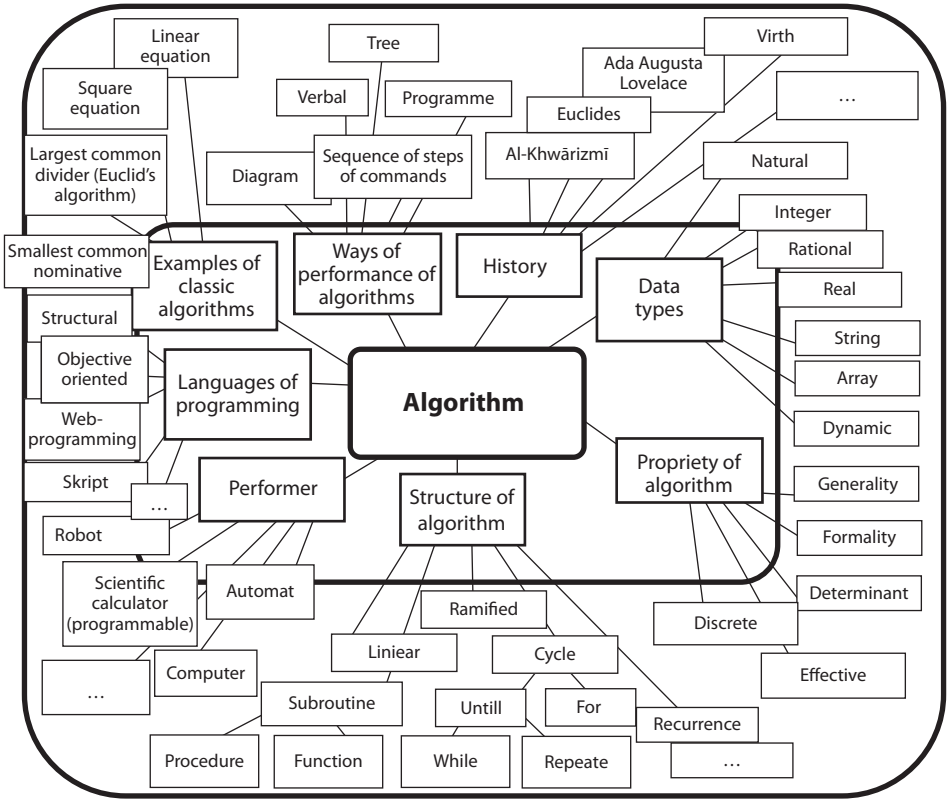
process, also to the vocabulary formed by a student or a group of students themselves. It can be multimedia hipertext vocabulary or wiki (open environmental hipertext or mini-thematic-encyclopaedia, similar to www.wikipedia.org), which is created by many users. There may be many different variants how to do this task: words may be presented to a student earlier for him/her to find the meaning and description (not fewer than 3 to each word), or give a topic, according to which a learner should choose 10 most important and meaningful words, phrases and later find their description using different resources, also the traditional ones: encyclopaedia, books, scientific works, and others, or electronic ones: database, electronic vocabulary, multimedia encyclopaedia, booklets, etc.

It allows learners to find necessary definitions of words and phrases, repeat their meaning, get acquainted with many approaches of formulated descriptions of different authors and various scientific conceptions. In this way, practically, in a very effective and intentional way one can use a systematic approach in learning the new school material and simultaneously, record the pupil's skills and habits in the range directed to the searching necessary items using ICT and content learning management systems (CLMS), particularly MOODLE.

The reflection in the graphic scheme including concepts in a whole interrelation helps the pupil to imagine additional associations, to remember the concepts in the schemes of thinking, transmit the knowledge of concepts obtained from one subject (sphere) to other spheres of science. One can create more spacious schemes, with more branches, taking into consideration the connections between intersubjects and execute them effectively in e-learning courses, particularly in the MOODLE system. Such an approach can assure elasticity and flexibility of thinking, the possibility of thought movement in different directions. In this way a pupil can get an opportunity effectively and adequately to the object of science to structure school material, aiming at the built-in subjective model of science or in the aim of the correction of the complex model.

From here it follows that the logical schemes of concepts are the spider net representation of system of concepts, based on *logically non-divided (indivisible) units of school material*. The logical schemes of concepts in a clear way reflect the diversity of object models of science, on the basis of which a scientific system of the views of an examined problem is formulated. Close schemes may be used in e-learning of any topics of a computer science course (also other subjects), also 'mathematical' as for example 'Arithmetic basis of computer.' The calculation systems or 'Algorithm'. The structure of algorithms and logical scheme of the concept of 'Internet' may look like these in Scheme 4.21.[Smyrnova-Trybulska, 2007, 2008]

Figure 1. Presentation of the logical spider net scheme of the concept '*Algorithm*'.



It is known that this scheme has an example look and can be in a simple way modified, updated, depending on the class level (normal, profile), in which the concept is taught-in middle school at an introductory level, or in secondary school at a higher, more formalized, advanced level (the rule of concentric and spiral shaped learning). The logical scheme of the concept of 'Algorithm' can be directly used in e-learning with the help of the above-mentioned functions of the MOODLE system. In a similar way as in the previous example, concerning the logical scheme of the concept of 'Internet', one can form thematic vocabulary, adding different examples of the use of algorithms of different structures, giving cross-references to others, in the inner resources of the Internet, etc., which can systematically and comprehensively teach a given topic and present pupils with the concept of algorithm and its structure.

One should remember that practically every concept has its own structure. For example, the concept of 'the media'. Thinking about this category one should analyse and consider minimum 4 inner parts of the structure and subcategories: *hardware* (a device, hard medium, paper, a book, a film, a TV set, a DVD device, a computer, etc), *software* (print, sound, a film, a photographe, a computer programme, etc.), *message* (an announcement about the sort of text, sound, a photo, a drawing, a vide image, a multimedia programme, a 3D picture, teleimmersion, etc.), *teachware* (a service instruction, help, methodological recommendation, for example: to the school computer science usage etc.) [Strykowski, 1997]

And only those who know and remember about this complex concept structure can in a more complex and objective way estimate the meaning of the concept of 'the media' and use it more effectively, in the right direction, and with greater awareness.

Practice of using logical schemes during the computer science confirms the following situation: the more mental effort to prepare school material and give it a totally conscious structure, the easier it is to handle it. The organization and introduction of the remembered material in a similar kind of structure make it better to reconstruct it, and significantly make it easier to search further. The scheme presentation of the logical concepts to pupils based on non-divided logical data units is the structural presentation of a new material in a natural language, which makes it possible to let pupils, in cognitive school acting, assimilate the new material (the level of assimilation according to W.P. Bezpalko). It also appears as one of the factors creating the situation of success in the further organization of cognitive school dealing with pupils.

The pedagogical practice, also in the conditions of e-learning, shows that such a presentation of school material makes the more conscious structuralization by pupils of the observed school material and on the basis of it a deeper understanding of the logical regularities and connections between the basic concepts of the subject taught. Purposely, the graphic system presentation of concepts goes with the process of learning of these concepts from the beginning of learning this subject till the final exam term. Having such an attitude, in the period of learning pupils get visible strength of schemes, which formulate in their mind, graphic symbols make sense, become fulfilled with contexts, specified, new associations appear which can strengthen the consciousness of the possesed knowledge.

The work of pupils when they are looking for places for new concepts in the existing structure is quite interesting. In such a process of working pupils should analyse the structure of their own knowledge, which lets them include the new information in the earlier structures of the knowledge and concepts obtained

before. One makes a suggestion that the pupils who revise all the thematic material through the same scheme of studied material structure, different from what was used by learning, may sometimes reach amazing results, and illustrate what a particular pupil recorded and did with the obtained data, which fully agrees with the statement that the grade of agreement of source information structure and the client of school material indicate the grade of understanding.

Building the informative-logical schemes based on not full (empty) spider nets schemes by pupils on their own makes the cognitive interest of pupils higher, lets them achieve better learning results. The ability to systematize information and presentation in different ways has also got an independent value, good for pupils' thinking development, useful for creating in them a system outlook on objects and phenomena in the surrounding world.

The logical schemes of concepts should be formulated by professionals (teachers, teacher supervisors, the authors of workbooks, etc.) on the basis of defined rules of their formulating, analyses of existing models in a concrete sphere of knowledge, the regularities of perception of school material by pupils and others. Schemes should be included in workbooks of each subject, such as geographical atlas to geography workbook, if possible in a multimedia hipertext form, by the way, the supplement of some schemes or the introduction of new items should be possible.

It is especially update in the computer science, because the contemporary informative-educational computer environment is, first of all, hipertext, so it is important to create in pupils the viewing description, the understanding of the rules of its constraction, the understanding how to deal with it, the ability of fast finding necessary items, the need to use cross-references and footnotes to key words.

The idea to use different schemes to the viewing presentation of concept systems in the computer science (more precisely in some of its chapters) is very important for the practical usage in the educational process during computer science lessons. Experiments carried out by scientists allow to come to the conclusion concerning high efficiency of the used logical systems of concepts in class activities and e – learning. So, on their basis, one can formulate the explanation of new teaching material: during the lesson and during the problem dialogue in the logical scheme of concepts, it easily finds its own place. At the same time, almost automatically such important didactic tasks are solved as: formulating the system viewing on the subject, formulating the orientational base of acting and others.

2. Modelling based on object concepts and the correlation between them

Another approach to the presentation of computer system activity is the application of the modelling based on object concepts and the correlations between them. Modelling makes the understanding easier not only of the system structure, but also the rules of its activity, moreover, in an easy way one can go from the general information to the details of the complete system activity.

In the beginning phase of the object modelling development one can propose many ways of the system presentation. : 1) Shlaer Mellor, 1988 [Fig. 2]; 2) Martin Odell, 1992 [Fig. 3]; 3) Booch, 1993 [Fig. 4]; 4) Coad Yourdon, 1991 [Fig. 5].

Figure 2: Class diagram of the simple system (strategic game) based on the Shlaer Mellor methodology.

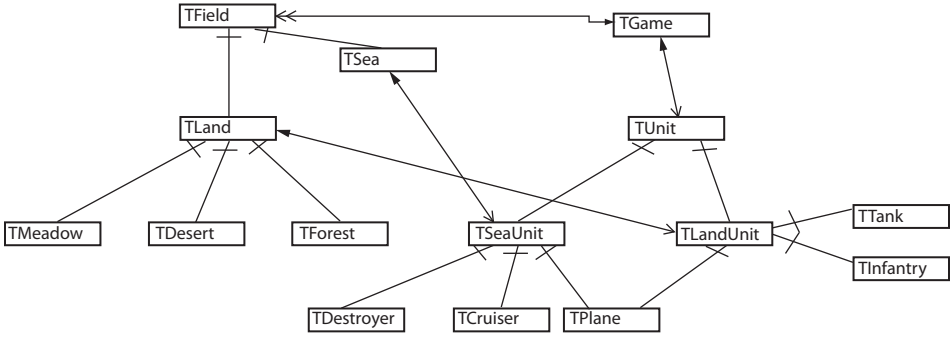


Figure 3: Class diagram of the simple system (strategic game) based on Martin - Odell methodology.

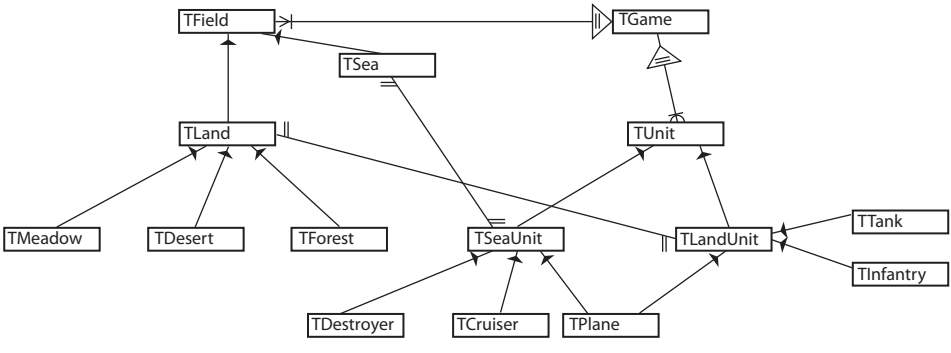


Figure 4: Class diagram of the simple system (strategic game) based on the Coad - Yourdon methodology

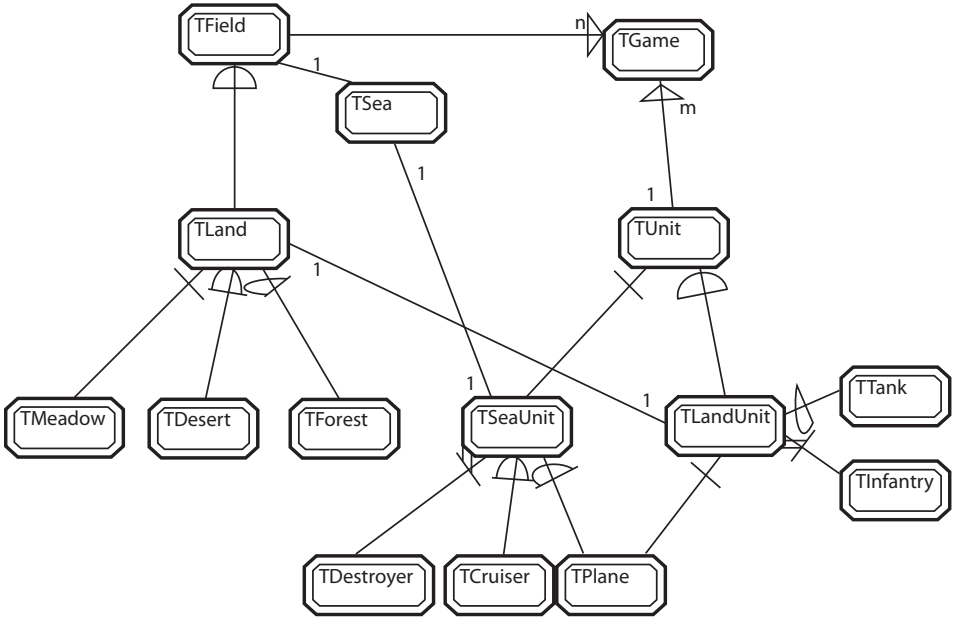


Figure 5: Class diagram of the simple system (strategic game) based on the Rumbaugh methodology

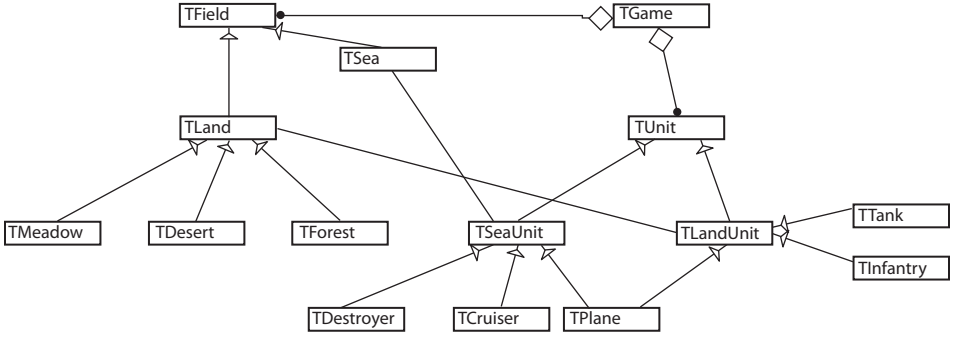
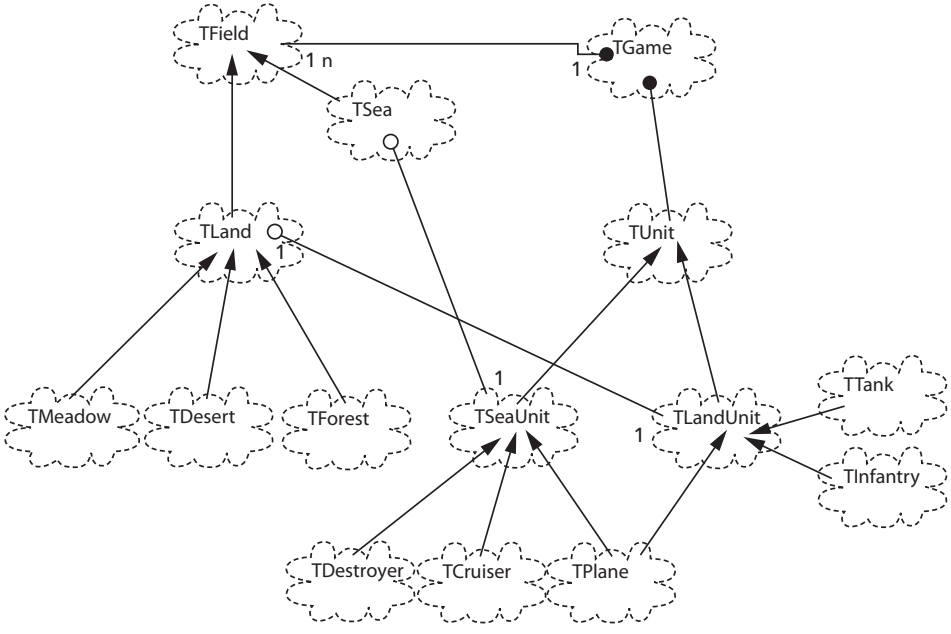


Figure 6: Class diagram of the simple system (strategic game) based on Booch methodology



The way of the presentation of concepts and models coincided with the spider net scheme. However, in the result of the development of object methods new diagrams explaining the dynamic aspects of functioning of the computer system appeared. One of the new attempts at an attitude to modelling and the presentation of the functioning of the computer system was the OMT technique (Object Modelling Technique), which after being borrowed from Booch and Jacobson's works is transformed in the UML language(Unified Modeling Language) .This language became the standard of the OMG (Object Management Group) organization.

The complete UML model of the system consists of three models: *static, dynamic, functioning* describing its different aspects. The static model contains the scheme system, diagram, or class diagram, diagram or object diagrams. The dynamic model illustrates other diagrams, for example: the cases of the usage, activities, state machine, interaction, sequence and communication, while the functioning model contains the detailed information about the algorithm of the acting of a particular object/class. (Detailed specified UML version and the description of diagrams can be found on : www.omg.org).

The pupil who is studying the UML model of the concrete computer system not only learns its elements, but also its principle of acting. From the static UML model, particularly from the class diagram, he/she learns what kinds of elements are included in the composition of the system and what features is the system characterized with – the description is included in the set of attributes and methods of the given class. Moreover, he/she finds the information about the correlation between classes: association, agregation, and generalization.

From the dynamic model he/she learns how the system deals with the relations to a concrete stimulus and examines the interaction of objects through watching the entrance events (stimulus) and exit (answers). Watching is not only applied to the dealing with the system as a whole, but also to the reaction of every element (object) (as far as such a need is required)

Such an analysis reflects the logic of the system and shows what can happen inside the system, when the outer stimulus appears. In the functional model a pupil learns with the transformations, equations or algorythms of object activities.

Teaching based on the UML methods was successfuly used in the subject of Basics of Engineer Software and System Designing at one of the Polish Higher Vocational School and during the subject of Basics of Engineer Software and System Designing in a technical school. The main aim of the introduction was to find the answer, whether the e-learning courses and blended learning, taking into consideration the use of UML, can effectively teach to formulate the computer systems fulfiling the previously established aims.

Pupils were to formulate a computer science task based on the general basis of system requirements, by the way the role of the teacher was directed towards starting (working on it) and the improvements of this course – in other words the independence of the pupil was emphasised.

After the participants of this course had learnt the general rules of programming and drawing the basic UML diagrams they were studying the rules of dealing with the computer science system based on diagrams and the students also were formulating their own systems and programmes. The results were encouraging – a lot of time was saved, so far wasted on the communication and explaination what tasks the system should fulfil.

The main value of the UML model is its totality – as static schemes in the concepts of brain maps, graphs, tree or nets, concentrate rather on the concept, the UML model apart from information what the computer system consists of, contains the information how it works, in a very simple way to understand. From this model one can easily make the simulation how the system works, which plays a very important role in learning its precise aspects of working, especially in

e-learning, where the teacher is not always available on-line and sometimes cannot give a quick answer.

The next value of using the UML methods is the possibility of using it by pupils themselves.

The pupil who is formulating the computer system scheme (e.g. programme) thanks to diagrams may immediately verify its work and make some necessary corrections. The more detailed diagrams the pupil can make the more knowledge he/she obtains, the knowledge how the system works, and how it models and also the pupil learns the method of the system presentation, the precision, the patience with searching for the information and how to show others his/her own solutions. In this way, he/she becomes not only 'a taker' of the presented knowledge of e-learning, but also 'an active creator', and what is very important, he/she learns on his/her mistakes without the negative consequences, such as a bad test result. The well-done task, despite the difficulties at the beginning, is the source of satisfaction and motivates for further, independent searching.

The last but also very important advantage of using the UML method is the possibility of automatic implementation of checking the correctness of diagrams by the e-learning system, which makes the teacher free from correcting the right acting of the arrangement and long time analysis of the model. The implementation of automatic checking of the system is not an easy task and requires help from the e-learning administrator, but all in all, the advantages of its implementation are so huge that it is beneficial to cover the costs of such an investment.

The small disadvantage of using UML to the description of the system for the pupil is the necessity to learn the UML language used in the concepts descriptions, so for that reason the introduction of this metod to the primary school is very controversial. However, the time devoted to the explanation of structure and diagrams is profitable later – an unambiguous and simple description of the system limits the possibilities of wrong interpretations of the structure and system work – language works well during the computer learning vocational subjects in secondary schools (technical schools) and at the higher schools, especially the teaching programming.

UML models may be also sucessfully used by the teacher to design the application which stimulates the work of concrete computer systems. Such applications are especially used in classes for young learners, where the direct usage of UML is debatable (the children's perceptive abilities should be taken into consideration, replacing the difficult details with more acceptable contexts).

Such applications (formulated on the basis of the UML method) have many values in comparison with the programmes created by the standard methods –

such values as: easier to analyse and any changes, simpler in conservation, well scaled and adaptable to different environmental and operative systems. Also they can be used in the new technologies of such types as Silverligh or Java/Java FX (and also Flash/Flex), including multimedia and integrated with the CLMS systems, for example MOODLE, will indicate and even now indicates a new way of e-learning in teaching the computer science as well as other subjects and spheres, favourable in increasing the quality of education and simultaneously encouraging and motivating learners to new scientific successes.

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